AD-A103 393 AUTOMETRIC INC FALLS CHURCH VA F/G 9/2
THE IMPLEMENTATION OF GRAPHICS SUPERPOSITION ON THE APPS-IV ANA--ETC(U)
FEB 81 C W GREVE, H A NIEDZWIADEK, G E LUKES
UNCLASSIFIED ETL-R023 NL

1 OF 1
AD A
103393

END
DATE
FILMED
10-81
DTIC

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ETL R023	2. GOVT ACCESSION NO. AD-A103	3. RECIPIENT'S CATALOG NUMBER 393
4. TITLE (and Subtitle) THE IMPLEMENTATION OF GRAPHICS SUPERPOSITION ON THE APPS IV ANALYTICAL PLOTTER		5. TYPE OF REPORT & PERIOD COVERED Paper
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Dr Greve & Mr. Niedzwiadek & George Lukes		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS US Army Engineer Topographic Laboratories Ft. Belvoir, VA 22060		12. REPORT DATE 27 Feb 1981
		13. NUMBER OF PAGES 14
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) LEVEL		15. SECURITY CLASS. (of this report)
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

2

AD A103393

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

DTIC ELECTE AUG 27 1981 H

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

computer-assisted photo interpretation research (CAPIR)
APPS-IV Analytical Plotter
geographic data base
graphics superposition

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The APPS-IV analytical plotter has been modified to permit the superposition of graphics data from a data base into the optical path. This data is projected into the stereo-model in photo image coordinates. Under real-time micro-processor control, the graphics display is translated on the face of the CRT to maintain registration with the image as the stage is moved. With graphic superposition, geographic data can be displayed directly in the stereo model as it is digitized. In addition, data previously compiled can be displayed as well as information from entirely different sources.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

DTIC FILE COPY

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

THE IMPLEMENTATION OF GRAPHICS SUPERPOSITION
ON THE
APPS-IV ANALYTICAL PLOTTER

Dr. Clifford W. Greve
President

Mr. Harry A. Niedzwiadek
Senior Scientist

Autometric, Inc.
5205 Leesburg Pike
Suite 1308/Skyline 1
Falls Church, Virginia 22041

George E. Lukes
Physical Scientist

U.S.A. Engineer Topographic Laboratories (USAETL)
Fort Belvoir, Virginia 22060

BIOGRAPHICAL SKETCHES

Clifford W. Greve received his undergraduate and Master's Degree level education at the University of Michigan, and obtained his doctorate in Geodesy and Photogrammetry at Cornell University. During his doctoral work, he was employed part-time by the U.S. Geological Survey, for which he performed numerous tasks in the analysis and design of solutions to analytical problems associated with geodetic surveying. Shortly after receiving his doctorate, he entered the U.S. Army, where he was actively engaged in geodetic and photogrammetric research while stationed at the U.S. Army Engineer Topographic Laboratories. He then accepted employment with Raytheon Company/Autometric where he managed the photogrammetric engineering group. Raytheon Company/Autometric became Autometric, Inc. on the 16th of March, 1977. Dr. Greve is currently President of Autometric, Inc., and is responsible for both the technical and business management of the company.

Harry A. Niedzwiadek received his B.S. degree from SUNY College of Environmental Science and Forestry in Syracuse, New York. While at Syracuse, Mr. Niedzwiadek worked for Synectics Corporation in Rome, New York, where he was involved in testing and evaluating automated cartographic equipment at Rome Air Development Center. In November 1974, he joined Raytheon Company/Autometric where he was involved in the design and implementation of analytical photogrammetric data reduction systems. At Autometric, Inc., Mr. Niedzwiadek has dealt primarily with the design and development of the Wetlands Analytical Mapping System, an integral part of Autometric's new AUTOGIS system.

George E. Lukes received the B.S. degree from the University of California and the M.S. degree from the American University. As an undergraduate at Berkeley, he was employed part-time by the U.S. Forest Service Remote

DTIC ELECTE AUG 27 1981

81 8 26 016

Sensing Project. Following graduation, he joined the staff of the University of California Forestry Remote Sensing Laboratory where he participated in the NASA Earth Resources Program. After entering military service in 1970, he was assigned to the USAETL Photo Interpretation Research Division as a member of an interdisciplinary terrain analysis research team. In 1972, Mr. Lukes joined the USAETL Research Institute where he has conducted research in automated terrain analysis. He is currently responsible for a program in computer-assisted photo interpretation research(CAPIR).

ABSTRACT

The APPS-IV analytical plotter has been modified to permit the superposition of graphics data from a data base into the optical path. This data is projected into the stereo model in photo image coordinates. Under real-time microprocessor control, the graphics display is translated on the face of the CRT to maintain registration with the image as the stage is moved. With graphic superposition, geographic data can be displayed directly in the stereo model as it is digitized. In addition, data previously compiled can be displayed as well as information from entirely different sources.

INTRODUCTION

The APPS-IV Analytical Plotter was originally developed as an efficient tool for the direct digitizing of geographic data base information from stereo photographs. From the inception of the development, it was evident to the personnel involved that an additional capability was required to permit the image interpreter to digitize the data in real time as he interpreted. The missing link was the capability for the interpreter to see what he had previously digitized. Separate CRT displays to the side of the instrument provide some aid, but in order to operate most efficiently, the operator must be able to see the graphics at the same time he is viewing the stereo model.

Under contract with the U.S. Army Engineer Topographic Laboratories, Autometric developed a capability to accomplish the superposition of the digitized graphic data into the stereo model as it is being digitized. With this capability, the APPS-IV becomes an instrument which will truly support real-time interpretation and simultaneous digitizing within the stereo model.

This paper will first discuss the implementation of the graphics superposition, and then describe uses of the media.

IMPLEMENTATION OF GRAPHICS SUPERPOSITON

At first glance the technique of superposition would seem obvious. One must introduce a beamsplitter into the optical train to allow the light from a graphics display to be introduced into the optical path and be superimposed on the imagery. Several technical questions had to be

considered as part of the design effort. The first question was whether to introduce the graphics into one or both optical paths. After analyzing the problem, it became obvious that the graphics could be introduced into only one optical train, since the graphics must coincide with at least one conjugate image to overlay the digitized point in the stereo model. Therefore, simplicity and economy lead to the decision to introduce the graphics into one optical train. The next fact which follows logically is that the graphics must be introduced in terms of stage coordinates of the points in the imagery, since doing otherwise would cause the graphics to fail to overlap the digitized features in the imagery. This allows the graphics for a road, for instance, to overlay exactly the imagery of the road in one optical train. In fact, this effect is almost identical to that which is seen in most stereo digitizing of previously interpreted data, where an interpretation overlay is placed over one of the photographics. Of course, with the superposition capability the operator can see the drawing of the overlay as he outlines the feature with the floating mark.

As a by-product of the superposition capability, by placing a TV camera above the beamsplitter, one can tap out a one-to-one display of the imagery. This display permits others watching the compilation operation to observe the progress, and to be consulted should questions occur. This is obviously important in any training environment, but is also useful in illustration of compilation principles. In addition, use of a suitable camera and interface can provide digital images for digital image processing and pattern recognition experiments.

To simplify the optical system, the graphics CRT is viewed at the same magnification as the imagery. If one were to use an ordinary large tube, the width of the graphics line would be too large to permit any fine detail to be traced. To lessen the width of the line, Autometric obtained a smaller tube from the vendor. This tube has a resolution of 2048 x 2048, over an imaging area of 4 by 4 inches, yielding a 2 mil resolution. The actual line width is about 4 mils, or 100 micrometers, which provides sufficient resolution in the optical overlay to define rather fine features, but is still broad enough to be readily seen by the operator.

Until now, only the static problem has been considered and the problem of linking the display coordinate system to the CRT screen has not been discussed. Normally, to determine a coordinate transformation, one would use the cursor in the APPS-IV to measure points. We wish to determine the stage position of points on the face of the CRT with respect to the stage, but unfortunately the measuring mark position is always fixed with respect to the screen, as the screen never moves. Thus, some other measuring mark must be used. Suppose one were to measure the position of a distinct object in the imagery, so that its stage coordinates were known. Now, by moving the measured mark

to overlay objects placed at known positions in the screen coordinate system, one could determine the relationship between the stage and screen coordinates, from a measurement of stage translations relative to the stage position when the distinct object was under the reticle.

Now consider an additional element of complexity. The image on the CRT must follow the stage position as the stage is moved. First of all, this obviously requires a refresh CRT, as a storage CRT obviously cannot slew the position of the image on the screen. In addition, there must be a capability to constantly monitor the stage position, so that the graphics position can be updated about twenty or more times per second to prevent the appearance of jerky movements. Moreover, to maintain the APPS-IV philosophy of not placing real-time demands upon the host computer, this must be accomplished internally to the APPS-IV instrument. The approach we used was that of adding a graphics control microprocessor to the instrument, which functions to determine the required position of the display in real time as the stages are moved by the operator. In addition, since points are being written to the display by the host as they are being compiled, this microprocessor must act as a multiplexer for commands from the host, so that commands to draw points from the host are not intermingled with commands to move the display from the microprocessor. Since both commands are strings of characters transmitted asynchronously over an RS-232c interface, characters from one command string could be interspersed with characters from another string, without this multplexing capability these mixed messages would appear to the display drivers as unintelligible. Thus the display microprocessor must buffer the messages until they are complete, and then send them out serially to insure message integrity. This microprocessor concurrently performs the rather extensive real-time floating point computations to determine the position of the display as a function of stage position of the APPS-IV. This microprocessor is isolated from the other APPS-IV microprocessors, even to the extent that while they share the same bus for communications, the Read-Only-Memory and Random-Access-Memory are on the display microprocessor board, so that accesses are made without bus priority. Thus there is no impact whatsoever upon the speed of normal stereo maintenance computations. The ability to control bus access to this extent is the result of the fact that the APPS-IV microprocessor design consists of a custom design developed specifically for this application. Such performance cannot be obtained from standard microprocessor boards available off-the-shelf.

USES FOR GRAPHICS SUPERPOSITION

It was originally conceived that graphics superposition would be used only for displaying what was currently being digitized, or at most, displaying the data set which was being edited. In this mode, the capability would allow the interpreter to keep account of his progress, and to see the nodes which he needed to join on the overlay, If the data being displayed were previously digitized data

(the capability is present to convert geographic coordinates back into image coordinates for display) the superposition capability gives the user a direct means for comparing previously digitized data bases with new stereo photography, which will greatly increase the efficiency of updating previous data base information with new photography on the APPS-IV. The operator can readily see what changes have occurred, and, using the editing features of the existing AUTOGIS software, can change the data base to reflect what is present.

Thus, graphics superposition provides a capability for interpretation and update using a stereo model that has not been previously available.

There is perhaps an even greater use for graphics superposition than that mentioned above, however. In the discussion above, we considered the display of information which was currently being digitized, or being updated. Suppose now, that one were to display other information than that being derived from the model. For instance, suppose that one was performing stereo geologic interpretation for oil exploration. One could display the magnetic or gravimetric map over the imagery, so that the geologic interpreter could see this auxiliary information visually, and thereby draw conclusions which might not become evident from the photogeology alone. Subtle features which he might normally overlook might become obvious in the context of explaining a magnetic anomaly which appeared on the overlay. Thus, for lack of a better term, the APPS-IV has become a tool to fuse the various types of input information. Because the stereo photogrammetric model is such a natural-appearing phenomena to most observers, the superposition of auxiliary information into this model provides a natural way in which to accomplish such synthesis.

In another arena, suppose that a military interpreter could see electronic intelligence returns superimposed over a current reconnaissance stereo model. Many more conclusions about enemy intentions and movements might be capable of being drawn than from the imagery alone. Yet another capability presents itself. There are many data bases which have been compiled previously, using methods which are not nearly as accurate as stereo photogrammetric compilation. Suppose that one were to bring these previous data bases up on the superposition display, along with new imagery. Without having to regenerate the data base, the operator could see the mismatches in the boundaries, and instruct the computer to move the coordinate system of the old data base a certain distance to accomplish a match. Through a sequence of such datum shift operations, a previously digitized data base can be updated in accuracy to fit a controlled stereo model without the necessity of having to redigitize each point in the data base. Whereas redigitizing all of the information in a stereo model might take several hours, this shift process would probably take only a few minutes per model. Thus, the accuracy of the old data can be

upgraded to meet higher standards, with far less cost than the cost of redigitizing the entire data base.

There are obviously other uses for graphics superposition. Rather than elaborate here any further, it is appropriate to discuss further developments which are taking place. Autometric, Inc., is currently under contract to the U.S. Army Engineer Topographic Laboratories to add graphics superposition to the second optical train of their APPS-IV plotter. After this development is complete, many more possibilities will be present. One of the common mistakes of persons performing digitizing in a stereo model is neglecting to change the elevation as a feature is being followed. Were this feature to be converted to image coordinates from the geographic, and were the point elevations not correct, the graphics overlay line would appear to float in the air or sink beneath the earth. In fact, the operator would see this happening in a real time as he digitized, which would tell him immediately that his dot was not on the ground. Of course, experienced operators do not make this error, but many of the operators who operate APPS-IV's for digitizing operations have never seen a stereo instrument before, so such mistakes are more common.

Another obvious application would be verification of previously produced terrain models. By putting a small x or dot into the stereo superposition display for each point, and by using a high-resolution stereo photogrammetric model, the operator could observe the degree to which the dots matched the surface elevation. By using the APPS-IV floating mark to measure both the height of the surface, and the height of the dots, the bias could be determined at the location of each dot. In fact, model join lines or other anomalies which change the systematic bias can be detected as ledges in the fit of the overlay to the terrain, and the outline can be measured using the APPS-IV, and then a correction for bias applied. The operator will instantly see the effects of the change to the elevation matrix, and therefore can determine immediately when the proper corrections have been applied. Individual points which represent spikes can be edited in real time in a like manner.

Perhaps the most esoteric application of stereo superposition is in flight simulation. Since the height of the graphics above the terrain can be sensed visually by the operator, one could plot aircraft or remotely piloted vehicle flight paths on the graphics overlay, and the operator could see immediately the extent to which the proposed path clears terrain, and how the path would avoid missile defenses, radars, etc. Thus, a complete, interactive mission-planning center could exist. Pilots could sit down at an APPS-IV and actually fly the nap-of-the-earth mission before they climbed into the cockpit, thus increasing their confidence considerably in the reliability of their terrain avoidance plan. By seeing where the flight path went relative to enemy defenses (the defenses, of course, could be put up on the same overlay), the pilot

would get a better idea of how to fly the mission to avoid these obstacles.

CONCLUSIONS

It is evident that graphics superposition supplies a valuable tool for mapping, imagery interpretation, and military planning. The capability exists now. What is even better, the design of the standard APPS-IV is such that the capability can be added in a matter of hours to any existing APPS-IV having either the Bausch and Lomb Stereo Zoom Transfer Scope or the new model 3500 optics as a field retrofit. Thus, the decision to buy superposition, either single photo or stereo, does not have to be made at the time of the initial purchase. The software to drive superposition is presently incorporated in the AUTOGIS software package, and could be easily added to other APPS-IV packages. As with all other APPS-IV firmware, the instructions for interfacing from the host computer are explicit and straightforward.

Graphics superpositon has supplied the first truly real-time feedback of not only newly digitized, but also previously data-based, information to the operator, which can be used without removing the eyes from the eyepieces, and thereby losing visual accommodation. The potential uses are limited only by one's imagination.

DA

FILM